Management Recommendations for

Usnea hesperina Mot.

version 2.0

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SUMMARY

Species: *Usnea hesperina* Mot.

Taxonomic Group: Lichens (Rare Oceanic Iinfluenced)

ROD Components: 1, 3

Other Management Status: Oregon Natural Heritage Program: List 3 (more information is needed before status can be determined, but may be threatened or endangered in Oregon or throughout range); Natural Heritage Networks Rank: Global Rank G5 (demonstrably widespread, abundant, and secure), State Rank S2 (imperiled because of rarity or because other factors demonstrably make it very vulnerable to extirpation, typically with 6-20 occurrences) (Oregon Natural Heritage Program 1998). BLM Tracking Status (USDI Bureau of Land Management 1998).

Range: *Usnea hesperina* has a world-wide distribution, and is known from ten sites in the range of the northern spotted owl, with nine sites in Oregon. Seven of the sites are on federal land. It is known from Eugene District BLM ACEC near Heceta Beach; McGribble Campground, Siskiyou National Forest; and the west shore of Ozette Lake in Olympic National Park. Four sites are on lands administered by the Siuslaw National Forest--Eel Creek and the south shore of Clear Lake in the Oregon Dunes National Recreation Area; Cascade Head Experimental Forest; and Sutton Creek Recreation Area. Non-federal sites are Lighthouse State Park, Humbug Mountain se of Port Orford, and near Clear Lake Dunes County Park.

Specific Habitat: *Usnea hesperina* is an epiphyte on coniferous trees and hardwood shrubs in forested and shrubby habitats of the coastal fog belt. All known sites are within 5 km (3 mi) of the Pacific Ocean. Some old trees or shrubs are present at all sites. The sites are exposed, such as a forest headland or ridge, or have exposed microhabitats.

Threats: Threats to *U. hesperina* are those actions that disrupt stand conditions necessary for its survival, including treatments that impact populations by removing coastal conifers and hardwood shrubs; alter the light, moisture, or temperature regimes; or deteriorate air quality. Such threats include fire (natural or prescribed), recreational development and activities, timber harvest, and off-road vehicles.

Management Recommendations:
- Manage known populations and the habitat area around them at all known sites.
- Develop practices to route human use away from habitat areas.
- Prevent fire in the population; manage fire in habitat areas.
- Restrict removal of trees, shrubs, or other vegetation from the habitat area, except when removal will not harm habitat integrity.

Information Needs:
- Visit known sites to determine extent of local populations, improve habitat descriptions, and clarify the association of this species with late-successional/old-growth forests.
- Determine whether additional populations exist in areas identified as suitable habitat.

Management Recommendations for *Usnea hesperina*

I. NATURAL HISTORY

A. Taxonomy and Nomenclature

Usnea hesperina Mot., Lich. Gen. Usnea Stud. Monogr., Pars Syst. 2: 383. 1938.

Synonyms:

Usnea hesperina ssp. *liturata* Motyka, Lich. Gen. *Usnea* Stud. Monogr., Pars Syst. 2: 384. 1938.
Usnea elongata Motyka, Lich. Gen. *Usnea* Stud. Monogr., Pars Syst. 2:411. 1938.
Usnea schadenbergiana Göpp. & Stein, 60. Jahresber. Schles. Ges. Vaterl. Cult.: 229. 1883.
Usnea subplicata (Vain.) Motyka, Lich. Gen. *Usnea* Stud. Monogr., Pars Syst. 2:558. 1938.
Usnea gracilis var. *subplicata* Vain., Ann. Acad. Sci. Fenn., Ser. A 6:7. 1915.
Usnea subgracilis Vain., Ann. Acad. Sci. Fenn., Ser. A 6:7. 1915.

Usnea hesperina Mot. was described by Motyka in 1938. It is a lichenized fungus in the family Parmeliaceae, order Lecanorales, class Ascomycetes (Tehler 1996). Motyka's species concept in the genus *Usnea* was largely influenced by geographic criteria, and some species common to different continents were described as different taxa. Motyka's material was recently re-examined by Clerc (1997), who concluded that *U. elongata, U. schadenbergiana, U. subplicata, U. gracilis* var. *subplicata,* and *U. subgracilis* are all synonyms of *U. hesperina*. In her recent treatise on *Usnea* in western Oregon, Pittam (1995) recognized two subspecies, *U. hesperina* ssp. *hesperina* and *U. hesperina* ssp. *liturata,* finding only the latter subspecies in her study area. Clerc (1997), Halonen *et al.* (1998), and McCune *et al.* (1997) all consider ssp. *liturata* a synonym of *U. hesperina*.

B. Species Description

1. Morphology and Chemistry

Usnea hesperina is characterized by its long, yellowish-green, pendent thallus, pale base, and strong annular cracks that become especially distinct towards the base (Figure 1). The branches are slender, epapillate and cylindrical (at most, slightly foveolate). The most variable characters are the frequency and distribution of the fibrils and soralia. The long, curved fibrils can be sparse to relatively abundant (Halonen *et al.* 1998). *Usnea hesperina* has superficial punctiform to tuberculate soralia, often becoming confluent near the apices. Immature soralia resemble pseudocyphellae. Isidiomorphs are sparse to scattered, forming on young soralia and regenerative parts of the cortex, often soon abraded (Herrera-Campos *et al.* 1998). The cortex is matte, soft and moderately thick (8-20%), the medulla is thin and compact (6-24%), and the central axis is thick (43-64%) (Clerc 1997,

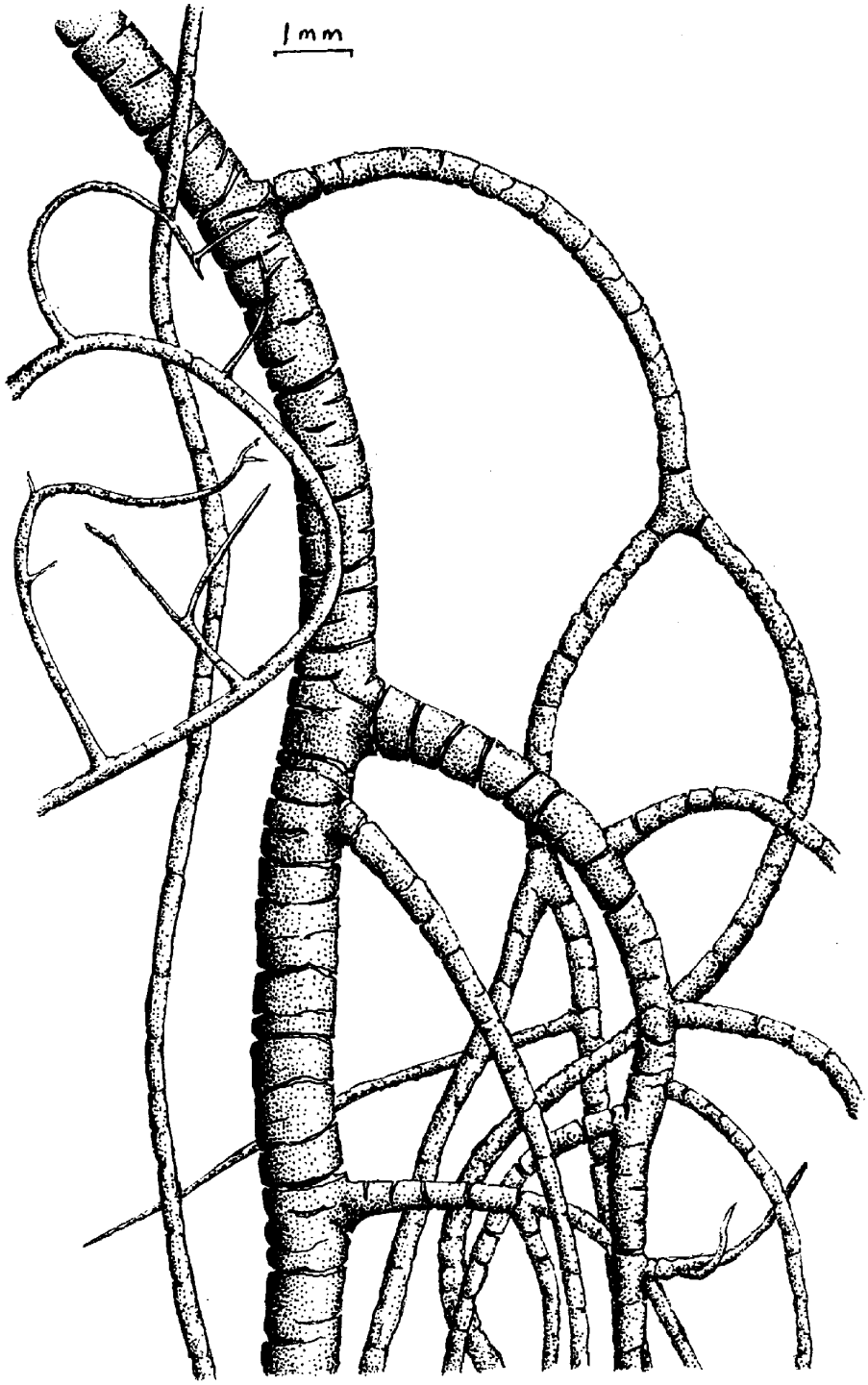

Figure 1. Line drawing of *Usnea hesperina* by Alexander Mikulin.

Halonen *et al*. 1998, Herrera-Campos *et al*. 1998). Apothecia are rare, known only from Mexican material; they are subterminal on small branches and fibrils (Herrera-Campos *et al*. 1998). *Usnea hesperina* contains usnic and protocetraric acids, with confumarprotocetraric acid (Cph-2) and traces of unknown substances. It is K+ yellow and PD+ orange (Halonen *et al.* 1998). A strain with usnic acid and compounds of the stictic acid group ("*Usnea schadenbergiana*") is found in the Philippines (Clerc 1997).

Usnea hesperina can resemble other pendent species of this genus in the Pacific Northwest. *Usnea trichodea* is also epapillate but is readily separated by its brown central axis; *U. chaetophora* is usually papillate, and has a blackened base, different cortex: medulla: axis ratios and different chemistry (Halonen *et al.* 1998). *Usnea subscabrosa* has a reddish base, and a thick, hard, shiny cortex. It produces soralia that are more variable in the same thallus and usually better developed than those of *U. hesperina*. Soralia of *U. subscabrosa* are small to medium-sized (about half the branch diameter), and are mainly convex and tuberculate, infrequently superficial and confluent (Herrera-Campos *et al.* 1998).

If thin layer chromatography is available, *U. hesperina* may be easily differentiated from other species by the presence of protocetraric acid as the main lichen substance. Most of the other species in the Pacific Northwest have only minor amounts of protocetraric acid, if any. Protocetraric acid can be the main substance in *U. cornuta sensu latu* (often), *U. glabrata* (often), and *U. rigida sensu latu*. These species differ distinctly in morphology from *U. hesperina*. *Usnea cornuta sensu latu* and *U. glabrata*, having shrubby thalli with distinct soralia, constricted branches and lax medullas. *Usnea rigida sensu latu* has a fertile thallus without isidia and soredia (Halonen *et al.* 1998).

2. Reproductive Biology

Sexual reproductive structures are unknown for *U. hesperina* in British Columbia (Halonen *et al.* 1998), or Oregon, and Washington (McCune *et al*. 1997), and are rare in Mexican material (Herrera-Campos *et al*. 1998).

Vegetative reproduction occurs by the production, dispersal and establishment of soredia, isidiomorphs and thallus fragments. The microscopic size of the reproductive propagules should allow them to be carried long distances by wind, animals, or birds. Birds in particular are thought to enhance arrival rates of rare oceanic species by dispersing lichen propagules along coastal migratory routes of the Pacific Northwest (McCune *et al*. 1997). In contrast, thallus fragments are heavier, fewer and therefore are likely to be most important for dispersal over short distances.

3. Ecological Roles

Usnea hesperina is a rare forage lichen. Squirrels, chipmunks, voles, pikas, mice, and bats and about 45 species of North American birds eat forage lichens or use them in nest building. A large variety of invertebrates including bristletails, barklice, katydids, grasshoppers, webspinners, butterflies, moths, lacewing larvae, mites, spiders, snails, slugs, and many beetles live on, mimic, or eat lichens (McCune and Geiser 1997). Fallen lichens are winter survival food for large

animals such as deer and elk when snow depth prevents browsing. After windy periods and after snow melt, large quantities of forage lichens in the genera *Alectoria*, *Bryoria* and *Usnea* may be found on the ground (Esseen *et al.* 1981, Stevenson and Rochelle 1984). During conditions of deep snow, they provide critical winter nutrition to deer (Stevenson and Rochelle 1984).

C. Range and Known Sites

In North America, *U. hesperina* is found on the Pacific Coast (McCune *et al.* 1997, Halonen *et al.* 1998), the Atlantic seaboard, notably the southern Appalachians (Dey 1978), and in Jamaica, Cuba (Clerc 1992, 1997), and Mexico (Herrera-Campos *et al.* 1998). It is also known from Europe, Asia, Africa, South America, the Canary Islands, and the Philippine Islands (Clerc 1997).

In the range of the Northwest Forest Plan, *U. hesperina* is known from 10 sites, 9 in Oregon and 1 in Washington. Eight of the sites are on federal land: Eugene District BLM Area of Critical Environmental Concern (ACEC) near Heceta Beach (Lane County), McGribble Campground in the Gold Beach Ranger District of the Siskiyou National Forest (Curry County), the west shore of Ozette Lake, in Olympic National Park (Clallam County) and four sites on lands administered by the Siuslaw National Forest. The Siuslaw National Forest sites are Eel Creek (Coos County) and the shore of Clear Lake (Douglas County) in the Oregon Dunes National Recreation Area; Cascade Head Experimental Forest (Tillamook County) on the Hebo Ranger District; and Sutton Creek Recreation Area (Lane County) on the Mapleton Ranger District. The remaining known sites are Lighthouse State Park (Douglas County), and the road to Clear Lake Dunes County Park (Lane County).

D. Habitat Characteristics and Species Abundance

In the range of the Northwest Forest Plan the distribution of *U. hesperina* is limited to the coastal fog belt; all known sites are within 5 km (3 mi) of the Pacific Ocean. It is found as an epiphyte on coniferous trees and hardwood shrubs in various forested habitats that share the following characteristics: some old trees are present on the site, the trees are in an exposed location (headland, ridge, windswept dune), or the host trees are exposed in the stand (meadow edges, patchworks of shrubs and deciduous trees that shed leaves during the peak growing season of lichens, scrub forests on stabilized dunes and wetlands). No large populations of this lichen have been found, but individual thalli have been observed in an increasing number of places.

The known substrates of *Usnea hesperina* are Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), Hooker's willow (*Salix hookeriana*), evergreen huckleberry (*Vaccinium ovatum*), Pacific wax-myrtle (*Myrica californica*), and Pacific rhododendron (*Rhododendron macrophyllum*). At Ozette Lake, Washington, it was found in the litterfall of a Sitka spruce/western redcedar (*Thuja plicata*) forest. In southern Oregon, Curry County, it was found in the litterfall of a large Douglas-fir in a Douglas-fir, Oregon ash (*Fraxinus latifolia*), and tanoak (*Lithocarpus densiflorus*) forest. At several sites (Clear Lake, Heceta Beach, and Lighthouse State Park), it was found in openings or edges of Sitka spruce and shore pine (*Pinus contorta*) forests on stabilized sand dunes. At Cascade Head, it was found on boles and branches of western hemlock in a young riparian stand with a few remnant old Sitka

spruce. It has not been found inland, despite systematic surveys on the Siuslaw National Forest and other forests of the western Cascades (USDA 1998). In British Columbia, *U. hesperina* is collected from conifers (*Picea* and *Tsuga*) along the hypermaritime seashore on Vancouver Island (Halonen *et al.* 1998). In the southern Appalachians, *U. hesperina* has a much more inland distribution and is common and widespread at lower elevations, where it occurs on hardwood trees, especially oak (*Quercus*) and birch (*Betula*), and rarely on rock and true fir (*Abies*) in communities dominated by hardwoods (Dey 1978).

II. CURRENT SPECIES SITUATION

A. Why Species Is Listed Under Survey and Manage Standard and Guideline

Usnea hesperina was thought to be at risk under the Northwest Forest Plan because of its rarity and limited distribution in the range of the northern spotted owl (USDA and USDI 1994a, 1994b). Ratings by the FEMAT lichen viability panel reflected a high level of concern for this species (USDA and USDI 1994a). The rare oceanic-influenced lichens as a group received the lowest viability ratings among all the lichens evaluated (USDA and USDI 1994a).

Because of the low viability ratings and high level of concern, this species was identified as a Survey and Manage strategy 1 and 3 species (USDA and USDI 1994c), with the dual objectives of managing known sites and conducting extensive surveys to locate additional populations and identify other high-priority sites for species management.

At the time of the viability panel, *Usnea hesperina* was known from only one site in the range of the northern spotted owl (USDA and USDI 1994a, 1994b). Work in this genus has been impeded until recently (Pittam 1995, Clerc 1997, Halonen *et al.* 1998, Herrera-Campos *et al.* 1998) by the lack of clear species descriptions and species concepts in the genus *Usnea*. Nine more locations have been found in the last few years, indicating that this species may be more frequent than was previously thought. None of the populations have been large, however.

B. Major Habitat and Viability Considerations

Frequent fog along the coast, combined with moderate temperatures, create the environment occupied by ocean-influenced lichens such as *U. hesperina*. The broken topography, natural firebreaks and ocean spray all act to reduce the influence of fire on the immediate coast. Migrating birds may enhance arrival rates by spreading lichen propagules. Higher species diversity, successful colonization by rare oceanic species, and reduced rates of population extirpations are natural features of immediate coastal habitats (McCune *et al.* 1997).

The major viability and habitat concerns for *U. hesperina* are the small number of known sites, the limited amount of suitable habitat for this species on federal land, and loss of populations because of management activities that directly affect the remaining populations, habitat areas or potential habitat. Much of the low-elevation coastal forest land in the Pacific Northwest is under nonfederal management and, along the immediate coast, development pressures are increasing. Outside of urban areas, privately owned forests are generally managed on short harvest rotations.

Given that lichens are slow to establish in rapidly growing stands (USDA and USDI 1994a), and do not become abundant until late in successional development, most of these stands are harvested before lichens have a chance to re-establish significant populations.

Isolation of populations also leads to genetic isolation. Almost nothing is known about the genetics of lichen populations or the effects of gene pool isolation on local extinction rates of populations.

C. Threats to the Species

Threats to *U. hesperina* are those actions that disrupt stand conditions necessary for its survival. Such actions include treatments that reduce local populations by removing colonized bark or wood substrates; decreasing exposure to light; adversely affecting integrity of habitat areas; reducing or fragmenting potential habitat; or degrading air quality.

Recreational activities and developments may inadvertently alter the habitat of this species. Trampling by recreational vehicles and frequent foot traffic are serious threats, especially in shore pine woodlands and edge communities, as these degrade the habitat by disturbing fragile root systems of trees and shrubs, and the fragile protective mats of ground cryptogams, which stabilize the soil (Christy *et al.* 1998). Destabilization of the foredunes by recreationists or removal of European beachgrass (*Ammophila arenaria*) can destabilize tree island habitats of *U. hesperina* by increasing the amount of sand drift into them and burying trees on the perimeter (Christy *et al.* 1998). Buildings, roads, campgrounds and trails along the immediate coast have replaced many natural habitats to improve access, facilitate scenic views, or develop recreational uses.

Other threats to the integrity of habitat and potential habitat areas include logging, grazing, agriculture, and activities which alter local hydrology, or increase fire frequency (Christy *et al.* 1998). Concern about fire varies--many different plant communities and successional stages exist among the coastal dunes and headlands; fire is beneficial to some communities but damaging to others. McCune *et al.* (1997) propose that natural firebreaks along the coast have promoted a rich diversity of rare lichens. In Sweden, *Usnea longissima* was not found in young forests (<110 years) but survived in old spruce forests along mire edges, wet depressions and north-facing hill slopes that had escaped forest fires (Esseen *et al.* 1981, Zackrisson 1981 cited by Esseen *et al*. 1981).

Invasion or planting of exotics such as Scots broom (*Cytisus scoparium*), European beachgrass, tree lupine (*Lupinus arboreus*), birdsfoot-trefoil (*Lotus corniculatus*), and iceplant (*Mesembryanthemum* spp.) can have profound effects on nitrogen-poor dune soils by increasing nitrogen and soil moisture. These conditions foster invasion of other weeds and eventually disrupt native plant communities (Christy *et al.* 1998).

Usnea hesperina is assumed to be sensitive to air pollution, especially sulfur dioxide. Most other pendent species of *Usnea* in the Pacific Northwest (McCune and Geiser 1997) and elsewhere (Wetmore 1983, Insarova *et al.* 1992) with known sensitivities have been rated as sensitive or extremely sensitive. Because the primary habitat of this lichen is the coastal fog belt, and

because fog significantly concentrates pollutants, especially acidic forms of SO_x and NO_x to which lichens are most sensitive, *U. hesperina* may be especially vulnerable to air pollution. Although air quality is relatively good at known sites, rising pollution emissions from increased traffic (mainly NO_x) and new or expanded industry (SO_x and NO_x) along the coast could threaten this species in the future. Climate change affecting coastal fog patterns could affect the vigor of this species, possibly resulting in an even more restricted distribution or contributing to local extirpation.

D. Distribution Relative to Land Allocations

Usnea hesperina is known from six federally managed administrative areas. The Eugene District BLM ACEC at Heceta Beach, Oregon, is administratively withdrawn. The Eel Creek and Clear Lake populations are in the Oregon Dunes National Recreation Area, which is Congressionally withdrawn, as is the Cascade Head Experimental Forest. McGribble Campground is in Matrix land on the Gold Beach District of the Siskiyou National Forest. The Sutton Creek site is part of Sutton Creek Recreation Area and is administratively withdrawn. The Ozette Lake population is in Olympic National Park.

III. MANAGEMENT GOAL AND OBJECTIVES

A. Management Goal for the Species

The goal for managing *U. hesperina* is to assist in maintaining species viability.

B. Objectives

Manage populations at all known sites on federal lands by maintaining habitat and potential habitat immediately surrounding known populations.

IV. HABITAT MANAGEMENT

A. Lessons From History

Habitat destruction or alteration has made a significant contribution to the decline of lichens world-wide (Seaward 1977). The extirpation or decline of these species has been attributed to both cutting of forest, short rotations between timber harvesting, air-quality degradation and slow dispersal and establishment rates of lichen species (Alstrup and Søchting 1989, Broad 1989, Esseen *et al.* 1981). Rare lichens limited to coastal habitats subject to many different human-caused disturbances, such as *U. hesperina*, are especially vulnerable.

Usnea hesperina is a rare forage lichen. Conversion of old-growth forests into young managed stands normally leads to a significant reduction in epiphytic lichen biomass, which in turn can have negative consequences for animals that use canopy lichens as food, shelter, or nesting material (Esseen *et al.* 1996). For example, Pettersson (1995) documented the loss of songbird

populations resulting from intensive forestry; short rotations reduced the biomass of lichens that supported insect populations which were the songbirds' primary food source.

Lichens have been known to be sensitive to air pollution for more than a century. Many species in Europe are in an active state of decline because of sulfur dioxide, nitrogen oxides, and acidic deposition of sulfur- and nitrogen-containing pollutants (Ferry *et al.* 1973, Hawksworth and Rose 1976). Fog contains higher concentrations of dissolved ions and acidity than do rain or snow (Wolseley and James 1992). Lichens that get most of their water from fog and dew, are particularly vulnerable to air-quality and weather- pattern changes (Nash 1996). Follmann (1995) documented massive impoverishment and retrogression of lichens over much of the northern Chilean coastal fog belt during the past 20 years. Increasing frequency of El Niño events and gradually increasing aridity were postulated as likely, but not exclusive, causal factors in this decline.

B. Identifying Habitat Areas for Management

All known sites of *U. hesperina* on federal land administered by the Forest Service and BLM in the range of the Northwest Forest Plan are identified as areas where these management recommendations should be implemented. A habitat area for management is defined as suitable habitat occupied by or near a known population.

C. Managing in Habitat Areas

The objective of managing in habitat areas is to maintain the habitat conditions for *U. hesperina*.

Specific known habitat conditions for *U. hesperina* are the foggy coastal headlands, dunes, and wetland mosaics interspersed with pockets of old-growth conifers, Hooker's willow, and other hardwood shrubs. Specific recommendations are to:

- Determine the extent of the local population and habitat area with a site visit.
- Maintain the habitat and associated microclimate of the population.
- Maintain suitable habitat around the current host trees and shrubs, so that the lichen may have adequate new substrate as current substrates decline.
- Like other epiphytes, *U. hesperina* requires retaining groups of standing trees to maintain suitable microclimate and to aid dispersal. Sitka spruce, shore pine, Hooker's willow, and other hardwood shrubs support *U. hesperina* along the immediate coast within 3 km (1-2 mi) of the ocean. Harvesting or thinning trees and removing shrub or other vegetation in the population and the habitat area should be avoided unless these actions would do no harm to, or would improve, the habitat for *U. hesperina* (for example, to prevent heavy shading or invasion of weedy, non-host species).
- Develop practices to route human use away from the populations in habitat areas (for example, divert roads, trails and off-road vehicles). Trampling shrubs or cryptogam mats, compacting roots, damaging trees or branches that serve as substrates, introducing non-native species by seed dispersal or planting, can all adversely affect habitat integrity.

- Prevent fire in the population but utilize or prevent fire in habitat areas, depending on the role of fire in the plant community. Consider recommendations by Christy *et al.* (1998) for fire management in coastal plant communities.
- Restrict commercial collection of moss, fungi or other special forest products if these activities would adversely affect the integrity of habitat areas.

D. Other Management Issues and Considerations

- Consider opportunities for managing known sites during Forest Plan and Resource Management Plan revisions, such as Botanical Special Interest Areas, Areas of Critical Environmental Concern, or other administratively withdrawn designations, or by prescribing special standards and guidelines.
- Continue to work with state and federal regulatory agencies to protect air quality on federally-managed lands from on- or off-site emissions, especially of nitrogen- and sulfur-containing pollutants.
- Provide information about conserving rare lichens at visitor centers or other locations along the coast to build public support of conservation efforts and to discourage collection of specimens.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Revisit known sites to verify the species, determine the extent of the populations, and characterize their habitat conditions.
- Determine if *U. hesperina* meets the criteria for being closely associated with late-successional and old-growth forests.
- Determine the distribution of *U. hesperina* in the range of the Northwest Forest Plan in areas of potentially suitable habitat. Potentially suitable habitat is identified as coniferous forests of exposed foggy coastal headlands and ridges containing mature or old-growth trees, and the stabilized dunes and wetland mosaic interspersed with pockets of old-growth Sitka spruce, shore pine, Hooker's willow, and other shrubs. Areas with potentially suitable habitat are within 5 km (3 mi) of the coast and include Oregon Dunes National Recreation Area and Siuslaw National Forest lands; coastal BLM parcels, such as those adjacent to Cape Lookout; and other federal land along the coast from northern California to the Olympic Peninsula, Washington.
- Assign priority to Strategy 3 surveys in areas where management treatments or projects are scheduled or proposed on the Siuslaw National Forest and in BLM parcels along the immediate coast.

B. Research Questions

- What are the dispersal and growth rates of *U. hesperina*? What factors limit dispersal and growth? Which habitat characteristics are necessary for survival of *U. hesperina* propagules?
- Are some conditions unique to late-successional and old-growth forests critical to the survival of this species? How can young managed stands along the immediate coast be managed to conserve and promote populations of *U. hesperina*?
- How should refugial patches be distributed across the landscape to optimize recolonization into managed stands? What are the minimum and optimum patch sizes of colonized habitat necessary to provide for *U. hesperina*?

C. Monitoring Needs and Recommendations

- Monitor known sites for changes in microclimatic conditions, successional stages, and for inadvertent habitat damage from human activities or wildfire.
- Monitor dispersal patterns and reproductive rates of existing populations.
- Monitor dispersal of existing populations into managed stands.
- Monitor air-quality effects on *U. hesperina*. Evaluate point sources and regional and local urban emissions along the coast in the range of the Northwest Forest Plan. Monitor populations at highest risk.

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